Restructuring of Supply Chains Amid De-Globalization: A Case Study of the Semiconductor Industry

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Abstract. Against the backdrop of de-globalization, the global semiconductor supply chain is undergoing profound restructuring. This paper establishes a "geography-technology" dual-dimensional analytical framework, and systematically examines the driving mechanisms, practical dilemmas, and China's breakthrough paths of this round of restructuring by integrating theoretical analysis with multi-case comparisons. The findings are as follows: First, trade protectionism, the excessive expansion of security concerns, and crisis shocks are driving the supply chain logic to shift from "efficiency first" to "security first." The regionalized layout characterized by localization, nearshoring, and friendshoring has led to the "fragmentation" of the global market. Second, although the aggressive industrial policies of major economies such as the United States, the European Union, Japan, and South Korea aim to promote supply chain reshoring and alliance-building, they have intensified technological blockades and resource misallocation—while enhancing regional security, they have significantly increased costs across the industry. Finally, although China has established a policy framework for breakthroughs across the entire industrial chain, it still faces severe chokepoint constraints in advanced process equipment, core materials, and high-end talents, making the path to self-reliant and secure development extremely challenging. This study not only reveals the complex interaction between geopolitics and economic laws in this round of supply chain restructuring but also provides decision-making references for China to formulate precise industrial breakthrough strategies under the new global competitive pattern.

Keywords: De-Globalization; Semiconductor Supply Chain; Supply Chain Restructuring

1 Introduction

Currently, the global economic pattern is undergoing profound reshaping. Driven by the rise of trade protectionism, intensified geopolitical competition, and elevated national security considerations, the wave of "de-globalization" has emerged, prompting the core logic of the global supply chain to shift from "efficiency first" to "security and resilience first." As the cornerstone of the digital economy and a high ground in modern

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science and technology, the highly globalized supply chain system of the semiconductor industry has borne the brunt, becoming the focus and a key analytical window of this restructuring. Major economies including the United States, the European Union, Japan, and South Korea have successively introduced strategic industrial policies, aiming to promote the "reshoring" of semiconductor manufacturing or its transfer to "friendly-shore" alliances. This has intensified technological blockades and market segmentation, exposing China's semiconductor industry to severe chokepoint risks. Against this background, systematically studying the mechanism of de-globalization on the restructuring of the semiconductor supply chain and exploring China's breakthrough paths is of great theoretical and practical significance for safeguarding national industrial security and realizing the independent and controllable development of high-tech industries.

Building on existing literature, the marginal contributions of this paper are reflected in the following aspects: First, theoretically, this paper breaks through the limitations of a single perspective and innovatively constructs a "geography-technology" dual-perspective analytical framework. By integrating geography-based layout strategies driven by geopolitics and technology evolution paths into a unified system, it provides a more comprehensive theoretical support for understanding the rebalancing of supply chain security and efficiency. Second, empirically, this paper adopts a combination of multi-case comparison and policy text analysis to systematically examine the similarities, differences, and differential impacts of semiconductor strategies among key actors such as the United States, the European Union, Japan, and South Korea. It also delves into micro-mechanisms such as key equipment controls and technological standard fragmentation, providing new cross-country comparative empirical evidence for relevant fields. Third, in terms of practical concerns and policy implications, this paper focuses on China's breakthrough paths. It not only accurately identifies the chokepoint risks faced in core links but also proposes practical response strategies from the perspectives of industrial chain coordination and innovation ecosystem construction, providing important decision-making references for the country to formulate industrial security strategies.

The remaining structure of this paper is arranged as follows: Section 2 analyzes the theoretical mechanism of de-globalization driving supply chain restructuring; Section 3 examines the current status and dilemmas of the highly globalized pattern of the global semiconductor supply chain; Section 4 conducts a multi-case comparative study to explore the similarities, differences, and comprehensive impacts of semiconductor strategies in the United States, the European Union, Japan, and South Korea on the global supply chain pattern; Section 5 proposes the breakthrough paths and policy system for China to achieve independent and controllable semiconductor industrial chain amid de-globalization; Section 6 presents conclusions and policy implications.

2 Theoretical Mechanism of Supply Chain Restructuring Driven by De-Globalization

2.1 Driving Factors of De-Globalization

The current wave of de-globalization is a systemic transformation driven by the interweaving of multiple factors. First, trade protectionism is reshaping international trade rules through a combination of explicit and implicit means. On the one hand, tariffs are used as a direct weapon in geopolitical games; on the other hand, non-tariff barriers (such as the European Union's Carbon Border Adjustment Mechanism) under the pretext of environmental protection and technical standards are becoming increasingly institutionalized. The underlying driver behind this is the domestic social conflicts intensified by the uneven distribution of globalization dividends—for example, the loss of jobs and solidification of social strata in developed economies due to the relocation of manufacturing industries. Second, the concept of national security is rapidly expanding from traditional military fields to economic and technological fields. This trend is specifically manifested in the implementation of comprehensive technological blockades in cutting-edge technology fields such as semiconductors, "de-risking" reviews of core digital infrastructures such as 5G, and the decoupling of strategic supply chains (e.g., energy) directly triggered by geopolitical shocks like the Russia-Ukraine conflict. These measures have fundamentally undermined the foundation of trust and cooperation among countries. Finally, global crisis events represented by the COVID-19 pandemic have not only exposed the vulnerability of highly integrated supply chains in the face of disruptions but also elevated supply chain security to the core of national security strategies. The economic stagnation during the pandemic exacerbated social inequality, providing more support for anti-globalization political parties [1]; at the same time, the experience of medical supplies shortages also prompted countries to promote the reshoring of key industries and the establishment of strategic reserves through systematic policy transformations. These three forces interact and reinforce each other, jointly driving the global economic pattern to restructure from the old paradigm of "efficiency first" to a new paradigm of "security and resilience first."

2.2 Theories of Supply Chain Restructuring

Against the backdrop of de-globalization, theories of supply chain restructuring mainly develop along two dimensions—geography and technology—both pointing to the paradigm shift from "efficiency first" to "security and resilience first." First, in terms of the geographical dimension, restructuring is manifested in the parallel advancement of localization, nearshoring, and friendshoring strategies. Localization focuses on relocating national strategic industries such as semiconductors back to domestic markets, aiming to strengthen the independent controllability of core links and reduce excessive dependence on a single geopolitical entity. Nearshoring involves transferring production links to neighboring regions (e.g., Mexico), striving to balance cost efficiency and regional risks while shortening logistics routes and improving response speed. As a supplement, friendshoring emphasizes building a "trust circle" among politically trusted allies, sacrificing part of economic efficiency in exchange for long-term stability and security of the entire supply chain network. Second, in terms of the technological dimension, digital transformation has laid a data foundation for the modernization of supply chains. By widely applying technologies such as the Internet of Things (IoT) and cloud computing, enterprises can break down information silos and build a real-time, transparent full-chain data sharing platform, which enables precise decision-making and rapid response to external shocks (Christopher, 2016; Ivanov, 2020). Finally, intelligent upgrading based on digitalization is the key to achieving supply chain resilience and competitiveness. By using artificial intelligence (AI) and machine learning algorithms, supply chains can shift from passive response to active demand forecasting, risk identification, and path optimization. This "integration of digitalization and intelligence" ultimately shapes a modern supply chain system that can dynamically adapt to the external environment and possesses high resilience, agility, and competitiveness.

3 Current Status and Dilemmas of the Global Semiconductor Supply Chain

3.1 The Highly Globalized Pattern of the Global Semiconductor Supply Chain

The global semiconductor supply chain is undergoing a profound structural transformation, and its core dilemmas and future trends can be analyzed from three levels. First, in terms of the industrial pattern, the traditional vertical global division of labor model based on "efficiency first" is being broken. Geopolitical risks and supply chain security crises are jointly driving its transformation to a regionalized and localized model of "balancing efficiency and security." Industrial policies represented by the U.S. and EU Chips Acts are guiding leading enterprises such as TSMC and Intel to re-layout production capacity globally, marking the rise of regional clusters. Second, technological bottlenecks in the supply chain have become increasingly prominent amid the transformation, forming dual constraints in equipment and materials. The absolute monopoly of ASML (Netherlands) in Extreme Ultraviolet (EUV) lithography machines and Japan's dominant position in the market for key materials such as photoresists have become the focus of geopolitical games. U.S. export controls have further intensified chokepoint risks for specific countries (e.g., China) in the development of advanced processes. Finally, the evolution of technological innovation and market demand is reshaping the value focus of the supply chain. On the one hand, as Moore's Law approaches physical limits, advanced packaging technologies represented by Chiplet and CoWoS have become key paths to continue performance improvement, driving the industrial chain to shift from fragmentation to in-depth integration [5]; on the other hand, the huge demand triggered by generative AI and automotive electrification has not only boosted the market for high-end computing chips and mature-process chips but also prompted leading enterprises to continuously increase R&D investment, further consolidating their market leadership and raising industry entry barriers.

3.2 Dilemmas Faced by the Semiconductor Supply Chain Amid De-Globalization

Amid the wave of de-globalization, the global semiconductor supply chain is trapped in a systemic dilemma where efficiency and security are difficult to balance, due to key technological blockades, policy uncertainty, and the overgeneralization of security concerns. First, the U.S.-led technological blockade has become increasingly stringent, forming a comprehensive chokepoint system covering equipment, materials, and EDA tools. By restricting ASML's export of advanced lithography machines to China, tightening Japan's supply of key semiconductor materials, and prohibiting the use of EDA tools for the design of advanced processes below 14nm, the industrial upgrading paths of late-developing countries have been systematically blocked. Second, the escalating policy uncertainty has significantly increased the risk of supply chain disruptions. U.S. export controls on high-performance computing chips (e.g., the NVIDIA H20 chip incident) and review barriers such as the EU's *Network Resilience Act* have jointly created a complex regulatory environment oriented toward "de-Sinicization," forcing enterprises to make strategic adjustments amid significant market uncertainty. Finally, the overgeneralized trend of "security first" is driving the global market toward fragmentation and leading to a sharp rise in supply chain costs. The U.S. and EU Chips Acts force the reshoring and regionalization of production capacity through high subsidies; this non-market-oriented resource allocation has led to redundant construction and efficiency losses globally. According to McKinsey's estimates, this may increase the average production cost of the entire industry by nearly 28%, which will ultimately be borne by the entire industrial chain and consumers.

4 Case Studies

4.1 U.S. Model: Reshaping the Global Supply Chain Pattern with the Chips Act

The United States is strongly leading the restructuring of the global semiconductor supply chain through aggressive industrial policies centered on the *Chips and Science Act*. First, the Act allocates a total of USD 280 billion, including approximately USD 52.7 billion in direct financial subsidies (USD 39 billion for incentivizing domestic factory construction and USD 11 billion for R&D) and a 25% investment tax credit for advanced manufacturing. It aims to attract large-scale reshoring of global semiconductor manufacturing to the U.S. with unprecedented efforts. Second, its core strategy embodies the dual goals of "incentivization and restriction." On the one hand, it attempts to build an exclusive technology and supply chain bloc by forming mechanisms such as the "Chip 4 Alliance" (jointly with Japan, South Korea, and Taiwan, China). On the other hand, it uses strict "guardrail provisions" to explicitly prohibit enterprises receiving subsidies from expanding advanced process capacity below 28nm in "countries of concern" such as China within the next decade, thereby systematically curbing the industrial upgrading of competitors.

This series of measures is profoundly impacting and fragmenting the original globalized division of labor system, bringing multiple negative effects. First, it forces leading enterprises such as TSMC and Samsung to adjust their efficient global production layouts against the laws of the market economy, leading to global resource misallocation. Second, due to the significant cost disadvantages of the U.S. in labor, infrastructure, and operations (the cost of TSMC's Arizona factory is estimated to be 30%-50% higher), the profitability of relevant enterprises has been significantly eroded, and they face practical operational challenges such as shortages of skilled technical workers. Finally, this beggar-thy-neighbor policy has fragmented the open and cooperative global R&D network, hindering international technological and talent exchanges. It not only increases the risk of global technological standard fragmentation but also ultimately inhibits the overall innovation ecosystem and long-term development vitality of the global semiconductor industry due to redundant construction and reduced coordination efficiency.

4.2 EU Model: Pursuing Strategic Autonomy with the Chips Act

Facing its relative weakness in advanced manufacturing, the European Union launched the *European Chips Act* in 2022. Relying on its strong basic research capabilities (e.g., IMEC in Belgium) and equipment advantages (e.g., ASML in the Netherlands), it aims to systematically enhance the EU's strategic autonomy and market share in the global semiconductor field through large-scale investment and policy coordination. First, the Act plans to invest over EUR 43 billion in public and private funds, of which EUR 11 billion will be used to establish five pilot lines covering the entire chain from laboratories to wafer fabs, so as to strengthen R&D and innovation capabilities in cutting-edge processes below 2nm and specialty technologies such as FD-SOI (Fully Depleted Silicon on Insulator). Second, the Act relaxes state aid rules to incentivize member states to provide direct subsidies for wafer fab construction, attracting investment and ensuring the supply security of key chips. Its goal is to increase the EU's share in global semiconductor production from the current 10% to 20% by 2030. Finally, the Act also focuses on establishing a supply chain early warning and coordination mechanism covering the entire EU, aiming to achieve accurate forecasting of semiconductor supply and demand, so as to make rapid and coordinated responses in case of shortages.

The implementation of the Act is having a profound impact on the semiconductor supply chain pattern in Europe and beyond. First, it has significantly accelerated domestic capacity construction and the deepening of regional division of labor in Europe, attracting key enterprises such as Intel (2nm wafer fab in Germany), TSMC (automotive chip factory in Germany), and STMicroelectronics (FD-SOI factory in France) to settle in, focusing on strengthening its advantages in automotive electronics and specialty technologies. Second, the strategic focus of the EU and the policy orientation of the United States have formed a joint force, jointly promoting the accelerated separation of the "U.S.-EU technology circle" and the "East Asian manufacturing circle," forcing East Asian economies such as Japan and South Korea to increase domestic investment to cope with the risk of supply chain fragmentation. Finally, this transformation profoundly reflects the reshaping of global supply chain logic—enterprises are forced to make difficult choices between "low-cost globalization" and "high-cost regional security," and supply chain efficiency is fully subordinated to production stability and geopolitical security.

4.3 Japan-South Korea Model: Consolidating Key Advantages Amid Great Power Competition

Amid the global supply chain restructuring, Japan and South Korea— as key nodes— are adopting a dual strategy: participating in great power competition while consolidating their specific advantages. Japan focuses on strengthening its control over upstream materials and core equipment, expanding domestic production capacity through large-scale subsidies, and responding to U.S. strategies by implementing export controls on 23 types of advanced equipment, integrating into the U.S.-led system through "friend-shoring" strategies. While maintaining its dominant position in memory chips, South Korea seeks geopolitical balance: while joining U.S.-led alliances such as the "Chip 4 Alliance" and promoting leading enterprises to invest in the United States [2], it also launches the ambitious "K-Semiconductor Belt" strategy, planning to invest heavily to comprehensively enhance the manufacturing capabilities of the entire domestic industrial chain [3].

The strategic choices of Japan and South Korea have profoundly intensified the "grouping" and "camp formation" of the global semiconductor supply chain and subverted the regional cooperation pattern. The two countries have cooperated with the U.S. "de-Sinicization" strategy, and their technological controls and investment transfers have directly impacted the East Asian industrial cooperation network centered on China, Japan, and South Korea, fragmenting the original economic and trade relations. At the same time, their large-scale domestic subsidies, while forming camp synergy with the United States, have also triggered fierce technological and capacity competition in the region, intensifying redundant resource construction. These measures have jointly promoted the restructuring of Asia's semiconductor production network, forcing all participants to make choices between politics and efficiency, and further solidifying the pattern of industrial fragmentation and confrontation.

In summary, although the semiconductor strategies of the United States, the European Union, Japan, and South Korea have different focuses, they all point to the core trend of reshaping the global supply chain through aggressive industrial policies in the name of national security—marking the shift of industrial logic from "efficiency first" to "security first." The differences in their strategies are significant: the U.S. model is the most aggressive, aiming to build an anti-China technology alliance to consolidate its hegemony; the EU model focuses on "defensive" strategic autonomy, intending to make up for its shortcomings in manufacturing [4]; the Japan-South Korea model is typically "reactive," i.e., taking sides amid great power competition while consolidating their specific advantages. These differentiated strategies have jointly accelerated the "fragmentation" and "camp formation" of the supply chain, increased industry costs due to redundant construction and resource misallocation, and systematically excluded

China from the advanced process supply chain. Ultimately, the global cooperation system based on comparative advantages has been subverted, and all participants are forced to make difficult trade-offs between political security and economic efficiency.

5 Breakthrough Paths and Policy System for China's Semiconductor Industrial Chain Amid De-Globalization

Facing external technological blockades and supply chain restructuring, the breakthrough of China's semiconductor industry is a systemic project, with the core of achieving technological independence, industrial security, and enhanced global discourse power. It needs to advance in a coordinated manner from three dimensions: strategic paths, policy support, and practical dilemmas.

5.1 Breakthrough Paths for an Independent and Controllable Industrial Chain

China's breakthrough strategy is a multi-level layout covering "addressing weaknesses," "building comprehensive chains," and "achieving leapfrog development." First, concentrate efforts to tackle chokepoint technologies such as lithography machines, EDA tools, and core materials, reducing external dependence. Second, systematically build a safe and controllable industrial chain covering the entire links from design, manufacturing, and packaging testing to equipment and materials. Finally, pursue "leapfrog development" by developing third-generation semiconductors, RISC-V architecture, and advanced packaging technologies such as Chiplet, so as to establish advantages in new technology tracks.

5.2 Comprehensive National Policy Support System

The state has established a comprehensive policy support system from three aspects: fiscal and taxation, finance, and talent. In terms of fiscal and taxation, it provides gradient corporate income tax reductions and import tariff preferences for advanced manufacturing enterprises and key enterprises in the industrial chain. In terms of finance, with the "Big Fund" (China Integrated Circuit Industry Investment Fund), which has accumulated over RMB 680 billion in three phases, as the core, it guides social capital to invest in weak links such as equipment and materials, and supports enterprises to go public and raise funds through multiple channels such as the STAR Market. In terms of talent, it accelerates the cultivation and reserve of professional talents by establishing a first-level discipline in integrated circuits, deepening industry-education integration, and improving equity incentives and talent introduction programs.

5.3 Practical Dilemmas in the Breakthrough Path

Nevertheless, China still faces severe challenges in three aspects—technology, industrial chain, and talent—on its breakthrough path. First, technologically, due to the inability to obtain EUV lithography machines and high-end EDA tools, China still faces a huge technological gap in catching up with advanced processes below 7nm. Second, the degree of industrial chain autonomy is relatively low—core equipment and key materials such as high-end photoresists and large silicon wafers still rely heavily on imports, which restricts mass production capacity. Finally, there is a huge gap in high-end professional talents. Statistics show that the gap has exceeded 300,000, and the speed of talent cultivation and retention rate are both unable to meet the needs of the industry's rapid development, becoming a key bottleneck [5].

6 Conclusions

This study systematically explores the restructuring of the global semiconductor supply chain amid de-globalization. By constructing a "geography-technology" dual-dimensional analytical framework and combining multi-case comparisons of the strategies of major economies such as the United States, the European Union, Japan, and South Korea, this paper deeply analyzes the driving mechanisms, practical dilemmas, and China's breakthrough paths of supply chain restructuring. The findings are as follows: First, de-globalization has driven the core logic of the semiconductor supply chain to shift from efficiency priority to security-oriented regional competition, leading to the "fragmentation" of the global market. Second, the restrictive industrial policies led by the United States have intensified technological blockades and resource misallocation, plunging the entire industry into the dilemma of rising costs and declining efficiency. Third, although China has established a comprehensive policy support system for breakthroughs, it still faces severe constraints in advanced process equipment, core materials, and high-end talents. This study reveals the nature of supply chain restructuring under the interweaving of geopolitics and economic laws, and provides decision-making references for China to solve chokepoint problems and optimize industrial layout in the new round of technological competition.

Based on the research conclusions, this paper provides the following policy implications for China to address the challenges of the semiconductor supply chain: First, adhere to the dual-drive of the "Big Fund" and tax preferences, optimize resource allocation efficiency, and accurately tilt policies toward core chokepoint links such as semiconductor equipment and EDA tools. Second, build an industrial ecosystem under China's "dual circulation" development pattern—a strategy emphasizing the mutual reinforcement of domestic and international markets. Internally, encourage leading enterprises to form industrial alliances for collaborative research; externally, leverage market advantages to deepen technological and talent cooperation with non-U.S. blocs on the premise of adhering to bottom-line principles, avoiding complete isolation. Third, establish a precise talent support system: systematically solve the shortage of high-end talents by reforming university training models, deepening industry-education integration, and establishing internationally competitive incentive programs.

At the same time, this study also has limitations, which point out directions for future research. First, the research perspective can be further expanded to "swing regions" that are increasingly important in global supply chain restructuring, such as Southeast Asia and Mexico. Second, given the rapid and dynamic evolution of de-globalization and technological iterations such as AI and Chiplet, their long-term impacts on the supply chain need to be continuously tracked through model establishment. Finally, the specific implementation effects and cost-effectiveness of the macro policy recommendations proposed in this paper also need to be subject to more refined empirical testing through quantitative analysis and case studies.

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